Title:
Epileptic Seizure Pattern Detection and Prediction based on Statistical and Transform Domain Feature Optimization in EEG Signal

Abstract:
Epileptic seizure patterns detection and prediction by EEG signal analysis are as clinical applications in prevention, drug therapy, patient monitoring and important decisions of presurgical intervention. In this thesis, all of tests and proposed algorithms are applied on the collected dataset of intractable pediatric patients. For this purpose, a real-time processing framework consisting of offline seizure detection algorithm in combination with online seizure prediction algorithm has been presented. In offline algorithm, primitive and essential information of seizure attack prediction are prepared. After preprocessing stage, statistical histogram-based features of signal PDF are extracted. By defining a deterministic polynomial on the normalized histogram, a syntactic feature that is called Interpolated Histogram Feature (IHF) is introduced. On the other hand, Seizure Distribution Model (SDM) as a descriptor for statistical behavior of seizure signals has been represented. Optimal features using hybrid model of Bayesian classifier and Hunting Search (HuS) algorithm are selected. The MLP classifier by optimal features is improved in architecture and learning strategy. Then optimized MLP neural network is trained in the offline mode. In online algorithm, RLS filtering is trained to estimate the future samples of signal. With sample-by-sample signal estimation and setting the RLS adaptation method, suitable time of signal prediction is obtained. By enhanced adaptive filter and defining a novel density-based signal tracking scenario, a new algorithm for signal estimation is proposed. After predicting the EEG time series, the optimal features are extracted from each predicted epoch. The trained MLP classifier (from offline mode) recognize real-time the seizure and non-seizure patterns. Proposed signal prediction algorithm in the online mode has accuracy rate of 86.56% and precision rate of 86.53% simultaneously. The recall rate of seizure prediction patterns is 97.27% with the FPR of 0.00215 per hour. Ultimately, the time of seizure signal prediction is converged to 6.64 seconds.

Keywords:
EEG signals, Epileptic seizure, Offline pattern detection, Real-time signal prediction, Feature optimization algorithm